# Application of immobilized titanium dioxide photocatalysis for the treatment of microcystin–LR

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## Introduction

This research is currently focused on the development of efficient water treatment processes for the hepatotoxin, microcystin-LR (MC-LR). Both conventional and advanced oxidation technologies have been tested against this cyanotoxin. Pilot plant studies have shown that conventional treatment processes such as coagulation, flocculation, and sedimentation result in increased levels of soluble toxin. Chlorination, activated carbon adsorption, and chemical oxidation [ozonation, Fenton reagent (FR)] have been used for the inactivation, physical removal, and degradation of the toxin, respectively. A promising chemical oxidation technology for the treatment of MC-LR is titanium dioxide ($TiO_2$) photocatalysis. This emerging "green" technology efficiently performs water purification and disinfection. Due to high catalytic surface area and minimized mass transfer limitations, $TiO_2$ in suspension exhibits high photocatalytic activity. However, nanosize $TiO_2$ particles are difficult to handle and remove after their application in MC-LR treatment.

## Hypotheses

In this study, immobilized $TiO_2$ photocatalysis was utilized as a proposed alternative to suspended $TiO_2$ treatment for MC-LR. Immobilized $TiO_2$ has higher mass transfer limitations than the suspended $TiO_2$. Also, fewer active catalytic sites are available to the contaminant resulting in reduced photocatalytic activity. Thus, it is necessary to immobilize $TiO_2$ particles onto substrates and enhance the photocatalytic and structural properties of $TiO_2$ material. We are developing novel methods for fabricating porous and non-porous photocatalytic films that possess high photocatalytic activity for a given $TiO_2$ mass.

## Methods

Highly active photocatalytic films were prepared with two methods resulting into porous and non-porous films on glass and stainless steel substrate, respectively. The non-porous films are synthesized by a modified sol-gel method employing a mixture of titania sol and colloidal $TiO_2$ particles to immobilize commercially available $TiO_2$ powder nanoparticles. The porous films are prepared with an acetic acid based sol-gel method modified with surfactant templates.

## Results

Control experiments demonstrated the high stability of MC-LR. The observed degradation in all the experiments with the films is due to the photocatalytic properties of the titanium dioxide. Both dark reaction and direct photolysis of MC-LR showed no obvious degradation.

## Conclusion

The study showed that immobilized titanium dioxide photocatalysis could effectively destroy MC-LR in water, at concentrations up to 5000 ppb.